Fig.1

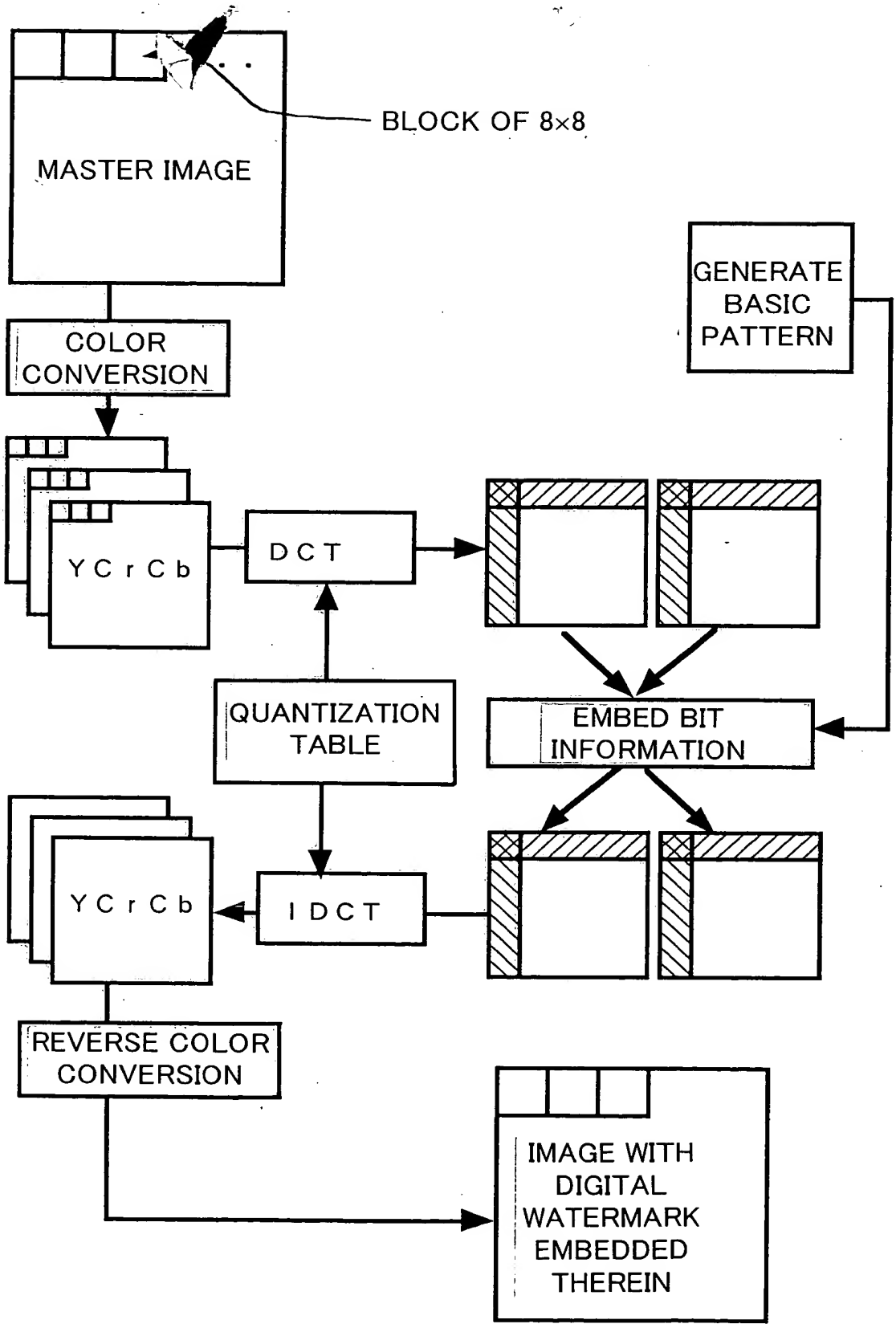
MASTER IMAGE
BLOCK OF 8×8
COLOR CONVERSION
GENERATE BASIC PATTERN
YCrCb
DCT
QUANTIZATION TABLE
EMBED BIT INFORMATION
YCrCb
IDCT
REVERSE COLOR CONVERSION
IMAGE WITH DIGITAL WATERMARK EMBEDDED THEREIN

Fig.2

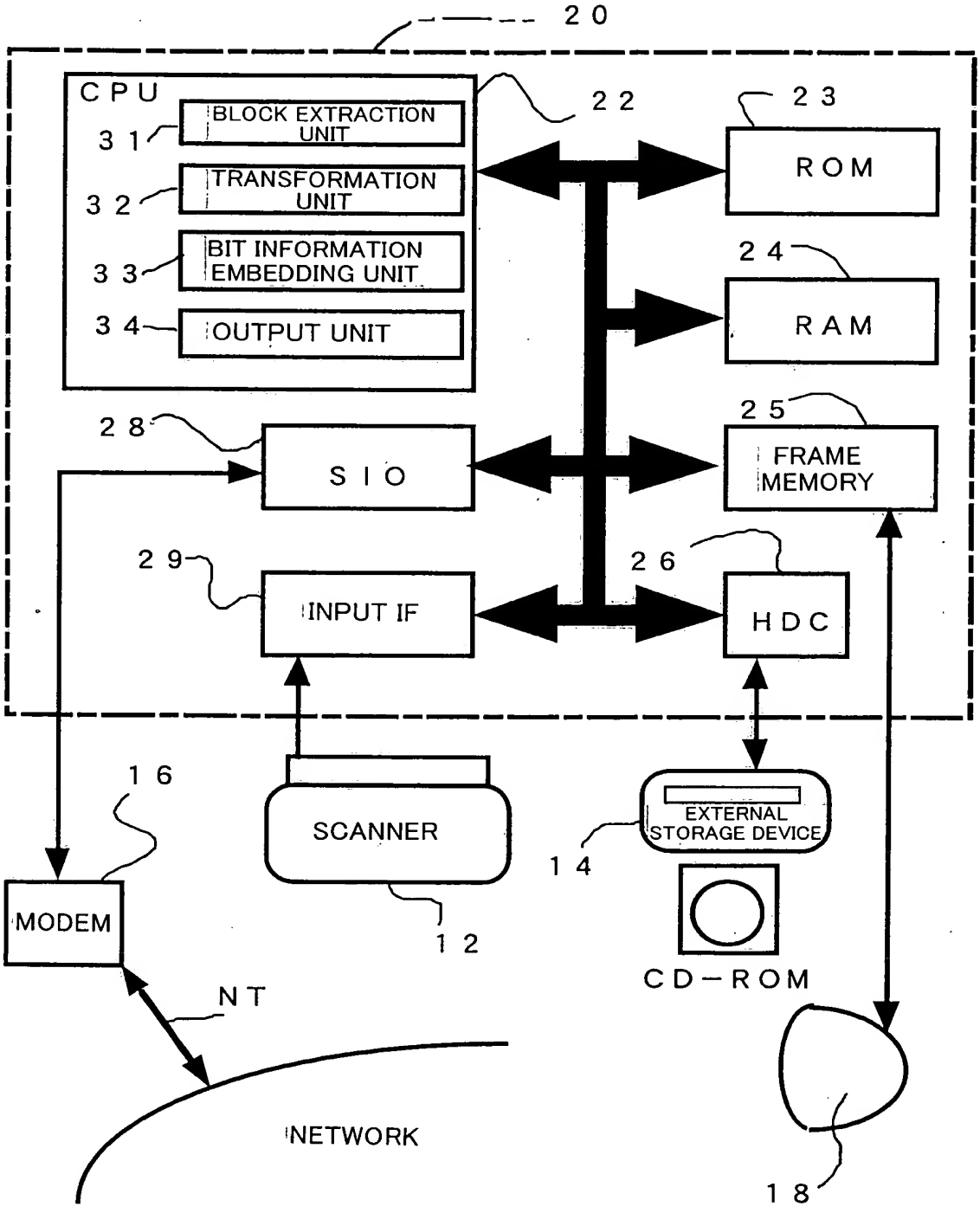
20
CPU
BLOCK EXTRACTION UNIT
31
TRANSFORMATION UNIT
32
BIT INFORMATION EMBEDDING UNIT
33
OUTPUT UNIT
34
22
23
ROM
24
RAM
25
FRAME MEMORY
28
SIO
29
INPUT IF
26
HDC
16
MODEM
NT
NETWORK
SCANNER
12
EXTERNAL STORAGE DEVICE
14
CD-ROM
18

Fig.3

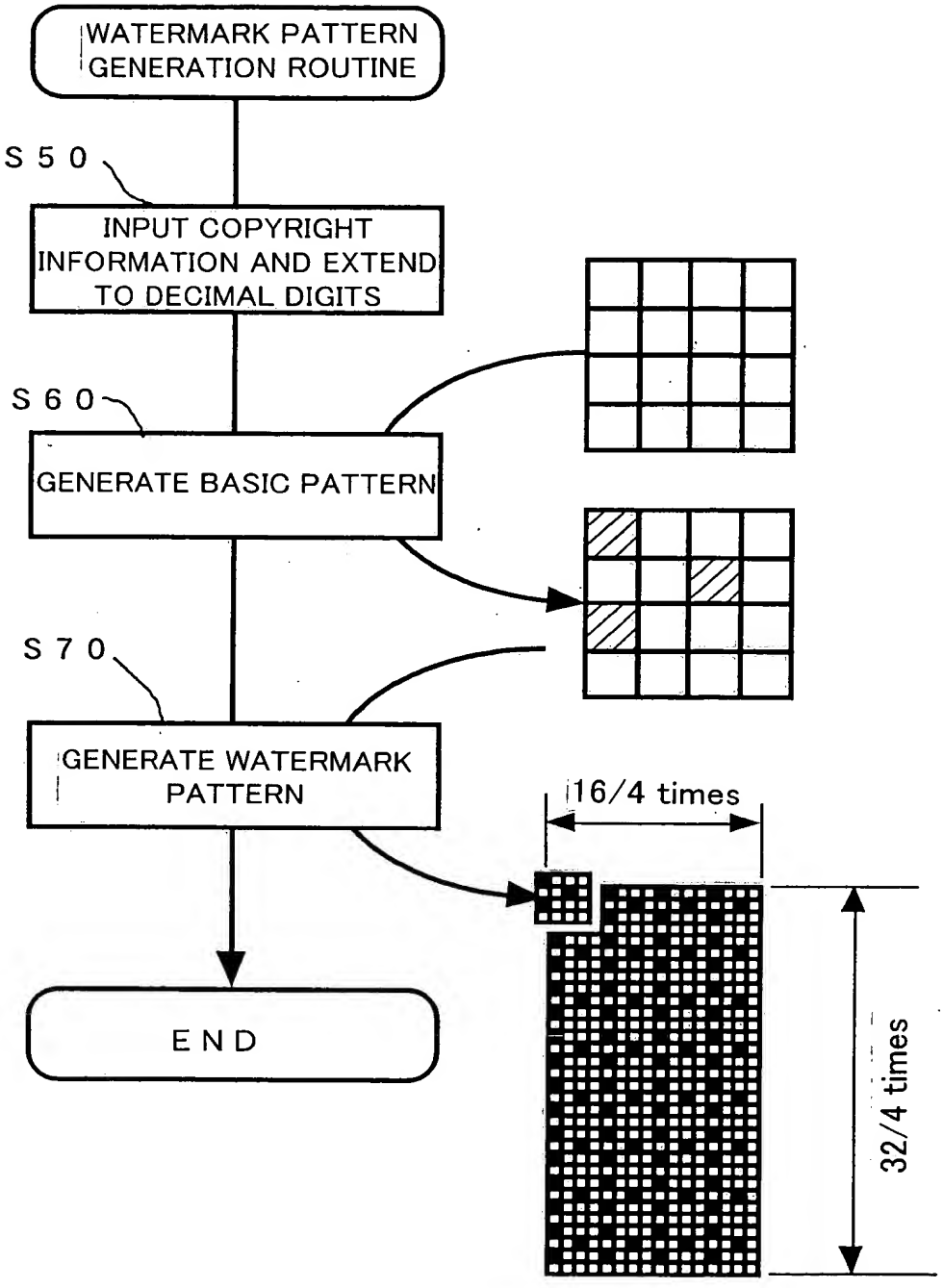
WATERMARK PATTERN GENERATION ROUTINE
S 5 0
INPUT COPYRIGHT INFORMATION AND EXTEND TO DECIMAL DIGITS
S 6 0
GENERATE BASIC PATTERN
S 7 0
GENERATE WATERMARK PATTERN
END
16/4 times
32/4 times

Fig.4

s (0)	s (1)	s (2)	s (3)
s (4)	s (5)	s (6)	s (7)
s (8)	s (9)	s (10)	s (11)
s (12)	s (13)	s (14)	s (15)

Fig.5

m	16πm	bm
1	16	4
2	120	6
3	560	9
4	1820	10
5	4368	12
6	8008	12
7	11440	13
8	12870	13
9	11440	13
10	8008	12
11	4368	12
12	1820	10
13	560	9
14	120	6
15	16	4
16	1	0

Fig.6

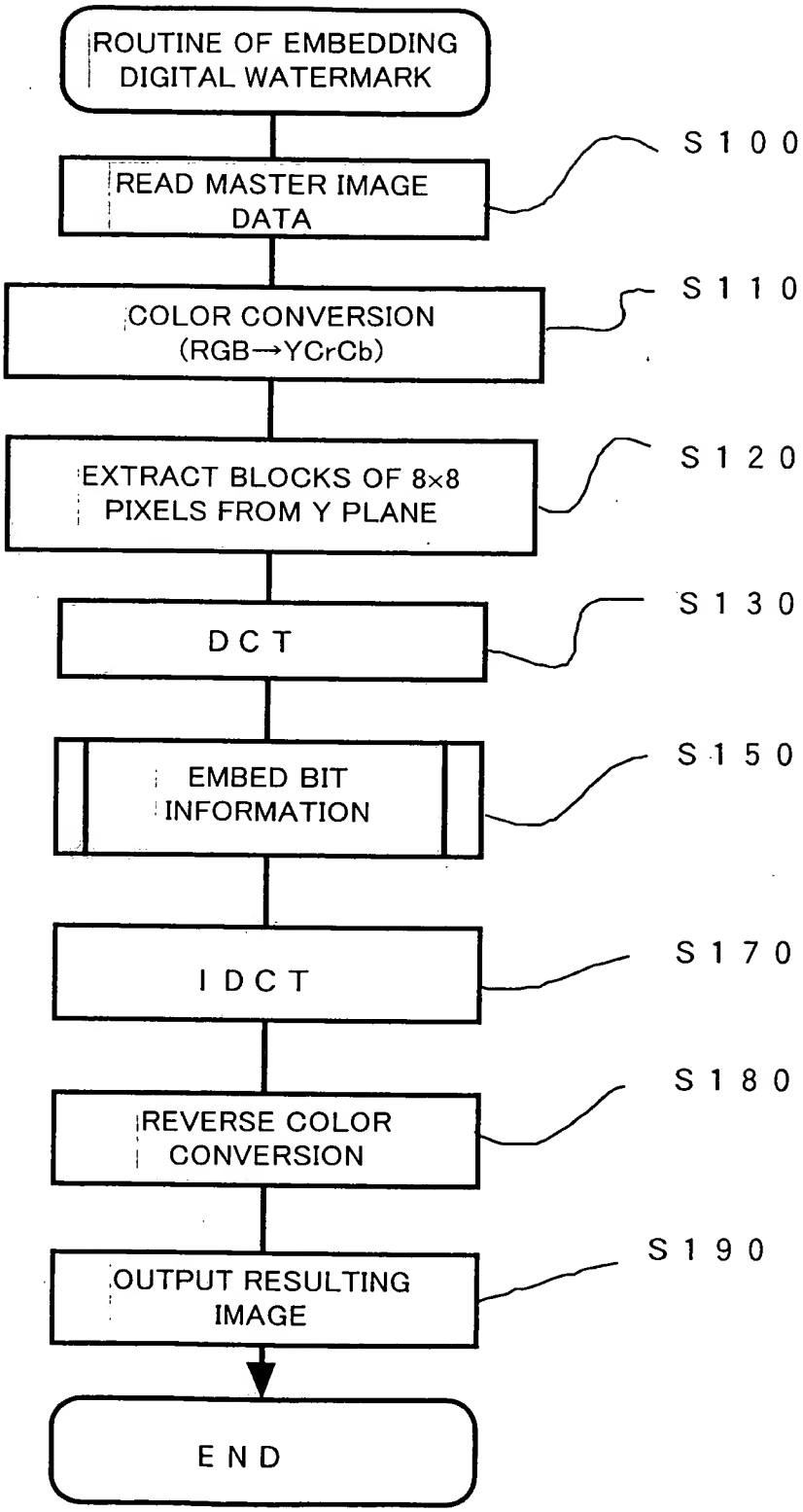
ROUTINE OF EMBEDDING DIGITAL WATERMARK
READ MASTER IMAGE DATA
S100
COLOR CONVERSION (RGB→YCrCb)
S110
EXTRACT BLOCKS OF 8×8 PIXELS FROM Y PLANE
S120
DCT
S130
EMBED BIT INFORMATION
S150
IDCT
S170
REVERSE COLOR CONVERSION
S180
OUTPUT RESULTING IMAGE
S190
END

Fig.7

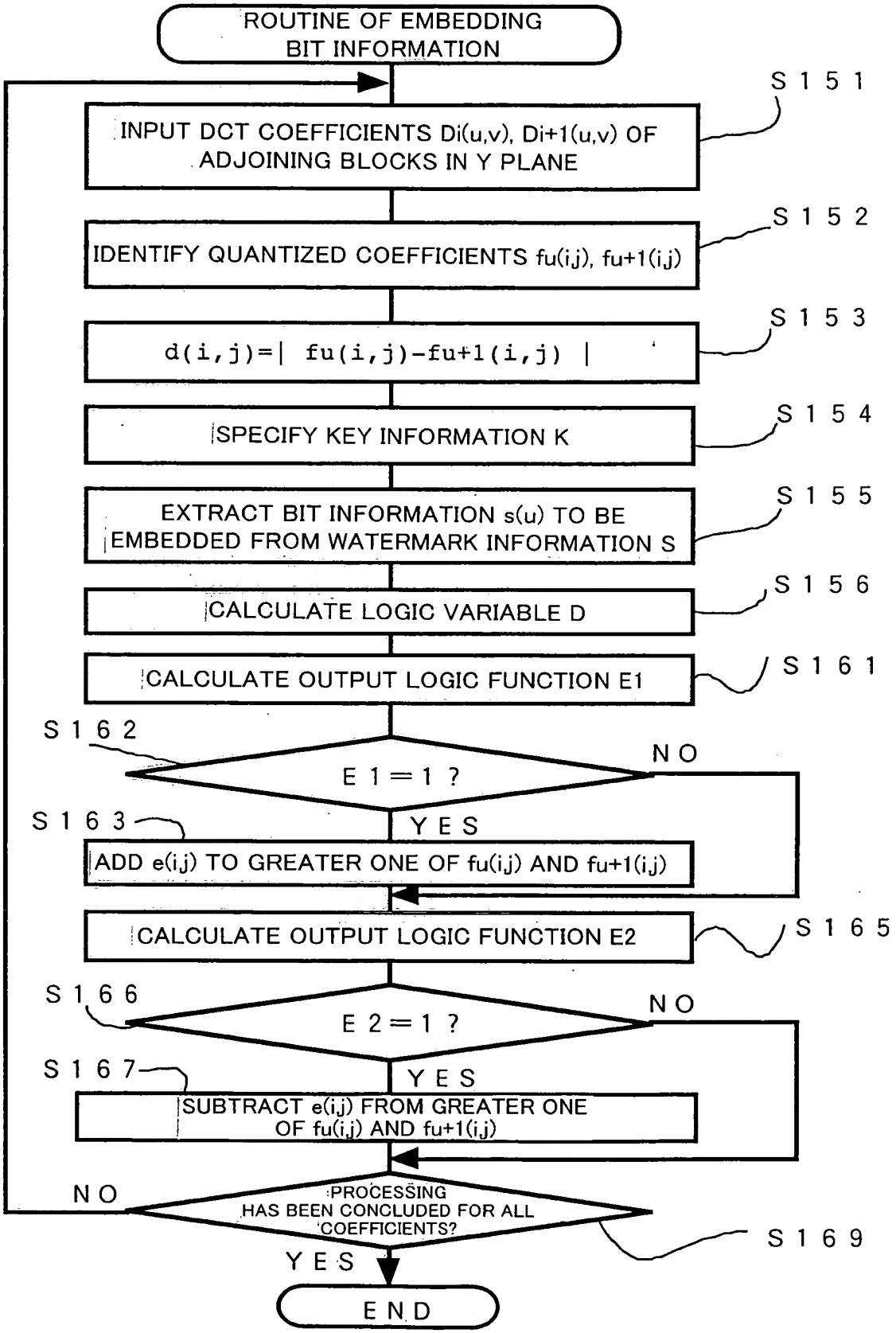
ROUTINE OF EMBEDDING BIT INFORMATION
S151
INPUT DCT COEFFICIENTS Di(u,v), Di+1(u,v) OF ADJOINING BLOCKS IN Y PLANE
S152
IDENTIFY QUANTIZED COEFFICIENTS fu(i,j), fu+1(i,j)
S153
d(i,j)=| fu(i,j)-fu+1(i,j) |
S154
SPECIFY KEY INFORMATION K
S155
EXTRACT BIT INFORMATION s(u) TO BE EMBEDDED FROM WATERMARK INFORMATION S
S156
CALCULATE LOGIC VARIABLE D
S161
CALCULATE OUTPUT LOGIC FUNCTION E1
S162
E 1 = 1 ?
NO
YES
S163
ADD e(i,j) TO GREATER ONE OF fu(i,j) AND fu+1(i,j)
CALCULATE OUTPUT LOGIC FUNCTION E2
S165
S166
E 2 = 1 ?
NO
YES
S167
SUBTRACT e(i,j) FROM GREATER ONE OF fu(i,j) AND fu+1(i,j)
NO
PROCESSING HAS BEEN CONCLUDED FOR ALL COEFFICIENTS?
S169
YES
END

Fig.8

DIFFERENCE \ DIGITAL WATERMARK		S				OUTPUT LOGIC FUNCTION
		0		1		
D	0	1	0	1	0	E1
	1	0	1	0	1	E2
KEY		0	1		0	
		K				

Fig.11

DIFFERENCE \ KEY		K	
		0	1
D	0	1	0
	1	0	1

Fig.9

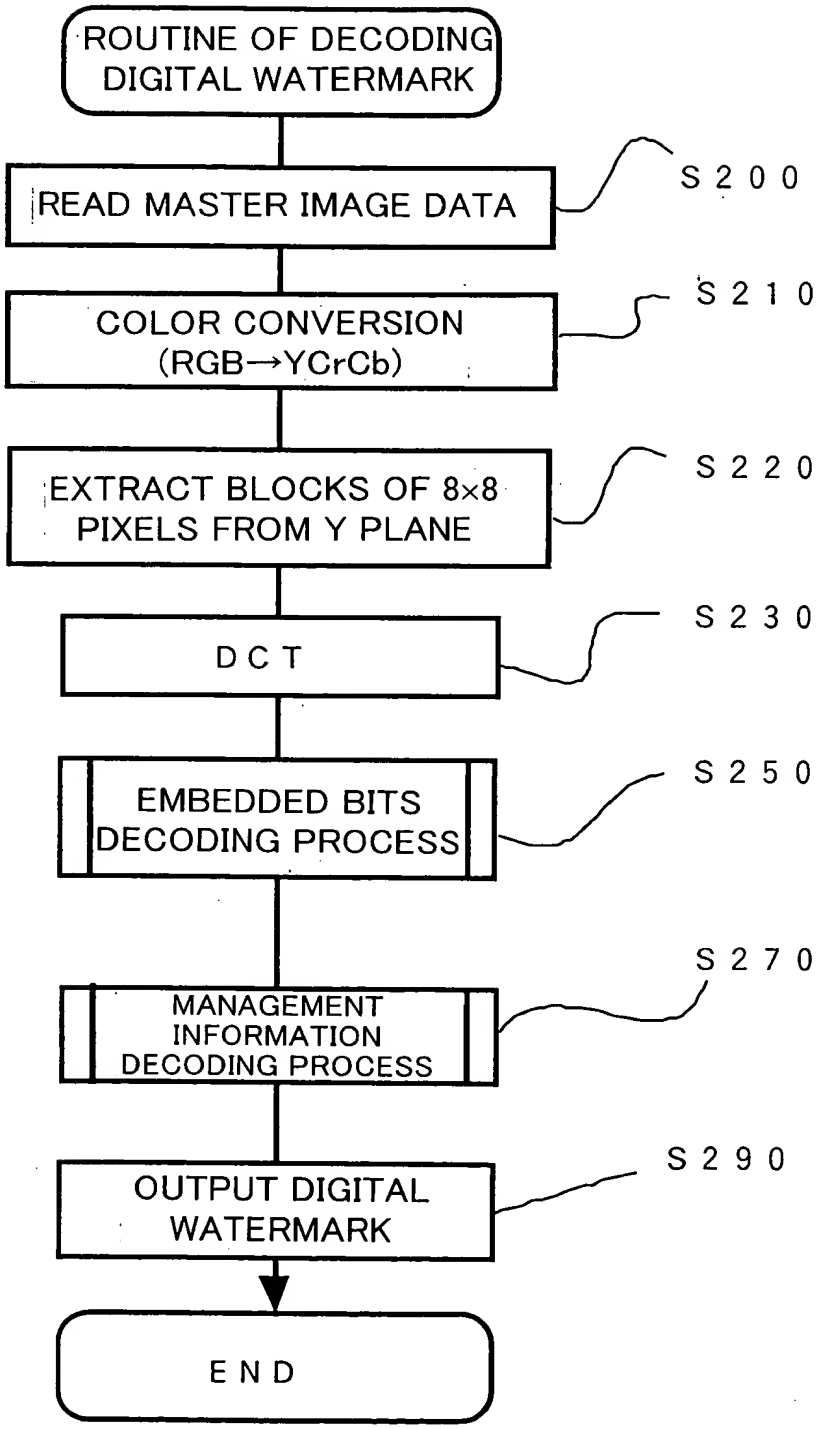
ROUTINE OF DECODING DIGITAL WATERMARK
READ MASTER IMAGE DATA
S200
COLOR CONVERSION (RGB→YCrCb)
S210
EXTRACT BLOCKS OF 8×8 PIXELS FROM Y PLANE
S220
DCT
S230
EMBEDDED BITS DECODING PROCESS
S250
MANAGEMENT INFORMATION DECODING PROCESS
S270
OUTPUT DIGITAL WATERMARK
S290
END

Fig. 10

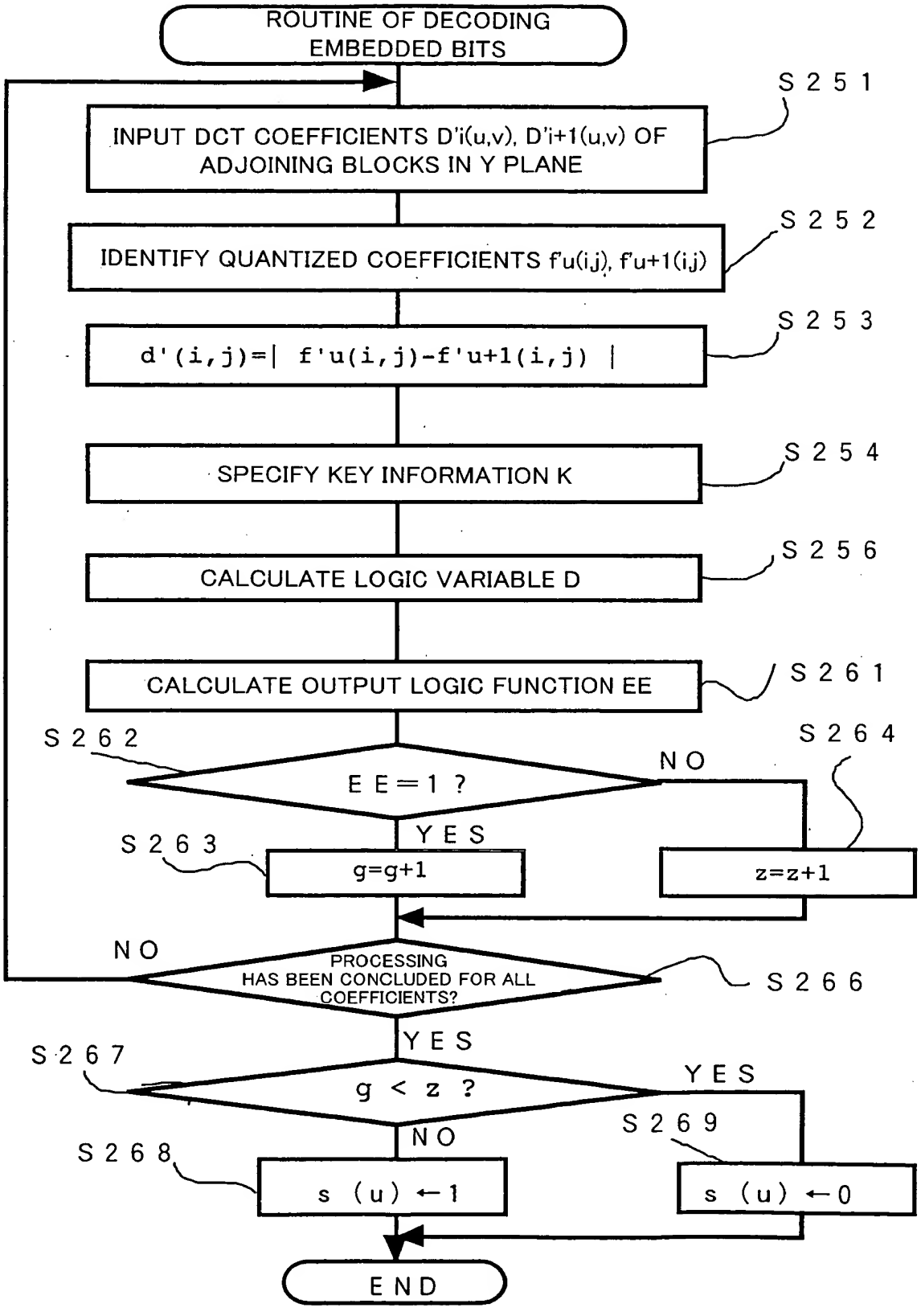
ROUTINE OF DECODING EMBEDDED BITS
S251
INPUT DCT COEFFICIENTS D'i(u,v), D'i+1(u,v) OF ADJOINING BLOCKS IN Y PLANE
S252
IDENTIFY QUANTIZED COEFFICIENTS f'u(i,j), f'u+1(i,j)
S253
d'(i,j)=| f'u(i,j)-f'u+1(i,j) |
S254
SPECIFY KEY INFORMATION K
S256
CALCULATE LOGIC VARIABLE D
S261
CALCULATE OUTPUT LOGIC FUNCTION EE
S262
EE=1 ?
NO
YES
S263
g=g+1
S264
z=z+1
NO
PROCESSING HAS BEEN CONCLUDED FOR ALL COEFFICIENTS?
S266
YES
S267
g < z ?
YES
NO
S268
s (u) ←1
S269
s (u) ←0
END

Fig.12

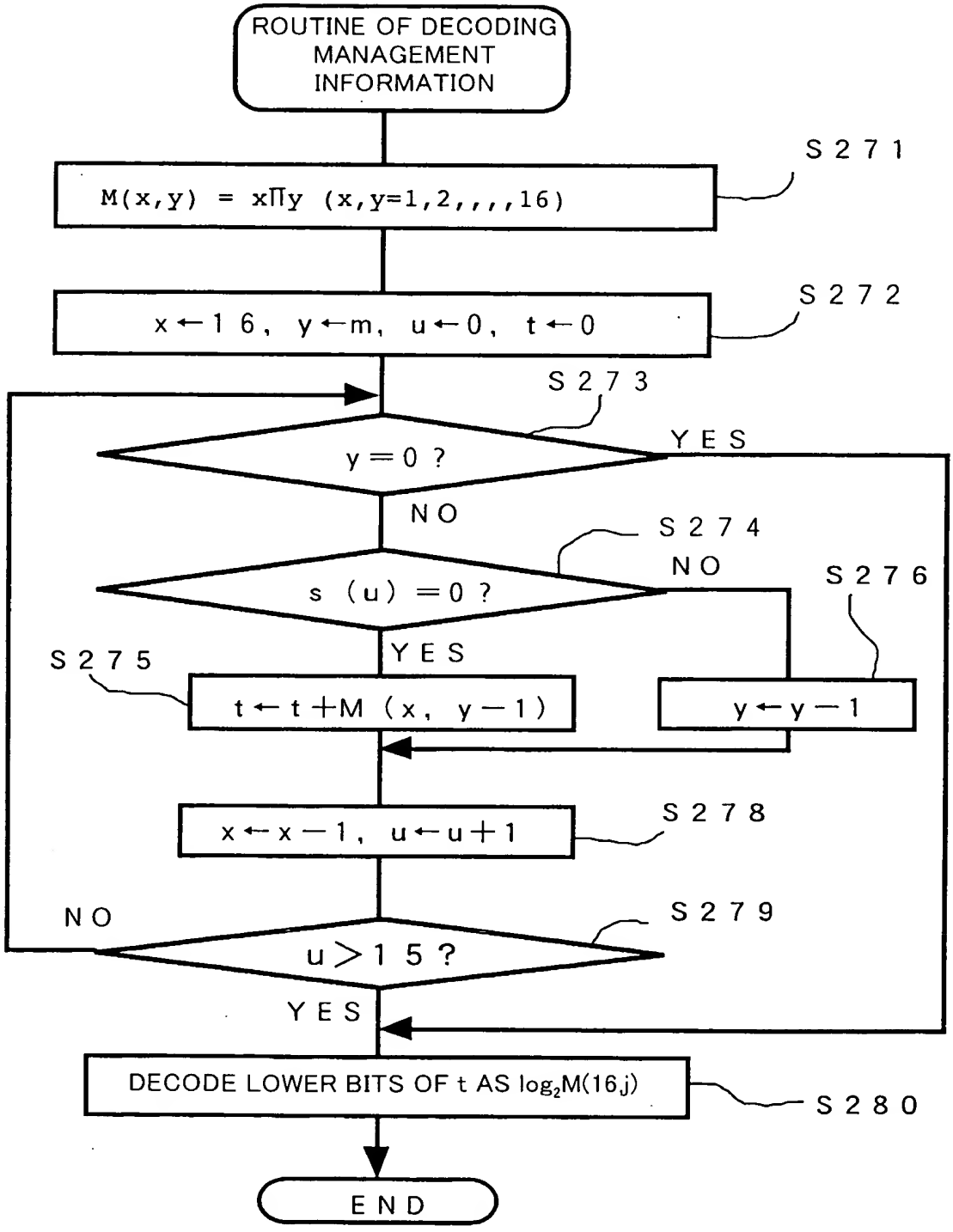
ROUTINE OF DECODING MANAGEMENT INFORMATION
S271
M(x,y) = xΠy (x,y=1,2,,,,16)
S272
x←16, y←m, u←0, t←0
S273
y=0 ?
YES
NO
S274
s(u)=0 ?
NO
S276
YES
S275
t←t+M(x, y−1)
y←y−1
S278
x←x−1, u←u+1
S279
NO
u>15 ?
YES
DECODE LOWER BITS OF t AS log2M(16,j)
S280
END

Fig.13

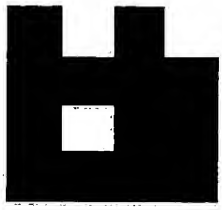

Fig.14

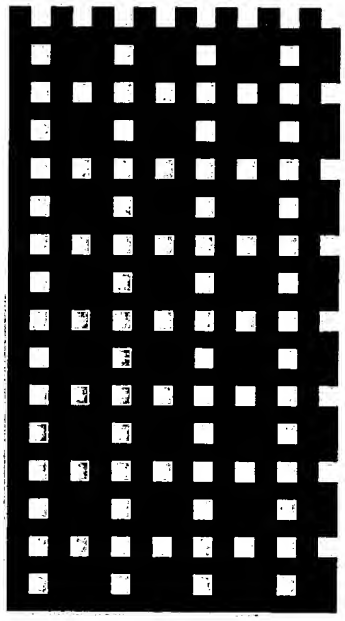

Fig.17

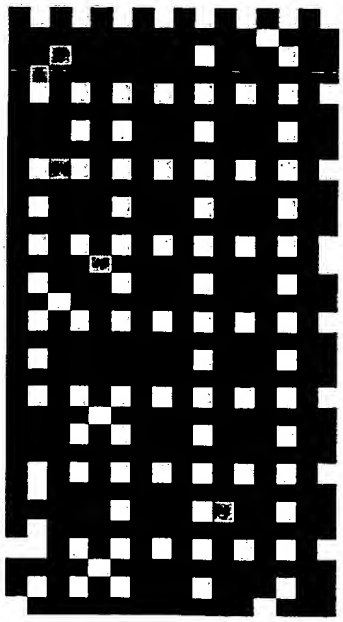

Fig. 15

Fig. 16